

Once again, Applicants' attorney is appreciative of the copy of the translation of this reference which was provided.

Regarding the rejection of Claims 1, 2, 4, 6 and 9 under 35 USC 103(a) over Pryor in view of the Japanese reference and Robyn et al, it has been agreed that Pryor teaches a method for filtering liquid metal through a bed of refractory material such as alumina, but does not teach the open porosity of the refractory material.

The Abstract of the Japanese reference states that the apparent porosity of a refractory material used to form molds is 20% or less, and the Office action makes reference to the Robyn et al patent for the proposition that apparent porosity has the same meaning as open porosity, based upon a statement at column 10, lines 9 through 12 of Robyn et al that "[t]he refractory mass formed on the surface of the wall has a total porosity estimated at about 70%, and an apparent porosity, that is the part of the porosity due to the open pores, of approximately 38%."

Applicants take issue with the allegation that Robyn et al teaches that open porosity *as used in the present specification* and apparent porosity have the same meaning, since Robyn et al *is not a dictionary*, but is only a patent which gives the patentee license to define terms as seen fit. The fact that apparent porosity has equated with porosity due to open pores for purposes of a fused wall coating in Robyn et al does not mean that apparent porosity is the same as open porosity for the granules of the Japanese reference or for the granules of the claimed invention.

Moreover, Applicants have found evidence that regardless of the meaning of the terms of Robyn et al, the meaning of apparent porosity of the Japanese reference is not the same as

the open porosity of the claimed invention. Applicants have taken note of paragraph [0049] of the translation of the Japanese reference, which states that "the measuring method of the apparent porosity of JIS R2205-74 refractory brick, water absorption and specific gravity" was used to measure the physical properties of the backing sand. Applicants have been able to locate a copy of this Japanese Industrial Standard R2205 dated 1992, copy attached, for placement into the record. Even though this Standard was actually published subsequent to the publication of the Japanese reference, Applicants have no reason to believe that it was not the standard in effect for determination of apparent porosity on the publication date the Japanese reference.

According to this Japanese Standard, apparent porosity is calculated by a formula defined in paragraph 5.1:

$$P_o = \frac{W_3 - W_1}{W_3 - W_2} \times 100,$$

where W_1 is mass of dried sample, W_2 is mass in water of a sample saturated with water and W_3 is mass of sample saturated with water.

Applicants have analyzed the above calculation as follows:

If V is the volume of the sample, V' the volume of the grains, V'' the volume of the closed pores of the grains, d' the intrinsic density of the grains and d the density of water, then:

$$W_1 = (V' - V'') \times d';$$

$$W_2 = (V' - V'') \times d' + (V - V') \times d - V \times d = (V' - V'') \times d - V' \times d \text{ [Archimedes' law]; and}$$

$$W_3 = (V' - V'') \times d' + (V - V') \times d,$$

thus:

$$P_o = \frac{((V' - V'') \times d' + (V - V') \times d - ((V' - V'') \times d'))}{((V' - V'') \times d' + (V - V') \times d) - ((V' - V'') \times d' + (V - V') \times d - V \times d)}$$

This equation reduces to

$$P_o = \frac{(V - V')}{V} \times 100$$

Applicants therefore have shown that what is intended to be measured in paragraph 5.1 is the *relative total open porosity* of the sample, that is the open porosity between the grains and the open porosity within the grains, as compared to the total volume of the sample.

Thus, it appears that Robyn et al and the Japanese reference are indeed both measuring the same quantity. This quantity is not, however, the open porosity which is the basis for the claimed invention, the open porosity *within the grains themselves*, which must be between 5 and 30%.

Moreover, with reference to paragraph [0019] of the Japanese reference, it is clear that an apparent porosity exceeding 20% is not desired because the particle strength is too low, and the particles are too easily crushed if one attempts recycling of these particles.

Applicants have discovered a feature which is not at all disclosed or suggested by the cited art references, that the removal of inclusions increases when filtering molten metal through grains having an open porosity between 5 and 30%. The only one of the cited references even concerned with

filtration of molten metal is the Pryor reference, which does not disclose the open porosity. While the Japanese reference does disclose apparent porosity, this is not the same as the claimed open porosity as has been pointed out above and the Japanese reference is not at all concerned with the ability of the grains to filter molten metal, but rather to resist crushing when grains are used to form a mold.

Thus, the cited references do not at all render the claimed invention obvious, and withdrawal of this rejection is requested.

Claims 3 and 11 have been rejected under 35 USC 103(a) over Pryor in view of the Japanese patent and Robyn et al and further in view of Brezny. While Brezny does disclose the claimed pore size for ceramic beads, the overall porosity disclosed by Brezny, 86%, appears much greater than that presently claimed. Thus, Brezny does not cure the defects of the references cited and discussed above, and withdrawal of this rejection is requested.

Claims 1, 4, 5, 7 and 9 have been rejected under 35 USC 103(a) over Hess et al in view of Neidhardt et al.

Hess et al has been cited for the teaching of filtering metal through a bed of refractory particulates, which is not disclosed as having the same porosity as the particles of the claimed invention. Neidhardt et al teaches electrofused corundum, and the Office action states that because this is the same method as that of the Applicants, the particles would inherently have the same porosity as those of the invention.

Applicants do not assert, however, that all electrofused corundum has the presently claimed porosity. It is clearly set forth at page 3, lines 6 through 19 of the specification, that electrofused corundum is preferred, but the cooling and

solidification state must be adjusted in order to obtain the desired open porosity. There is no evidence whatever that the electrofused corundum produced by Neidhardt et al would have the desired open porosity, and no suggestion that such an electrofused corundum would be an advantageous material for filtering molten metal, which has been shown in the present specification.

Withdrawal of this rejection is accordingly requested.

In view of the foregoing remarks, Applicants submit that the present application is now in condition for allowance and an early allowance of the application is earnestly solicited.

Respectfully submitted,



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JIS



JAPANESE INDUSTRIAL STANDARD

**Testing method for apparent
porosity, water absorption
and specific gravity
of refractory bricks**

JIS R 2205—1992

Translated and Published

by

Japanese Standards Association

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

JAPANESE INDUSTRIAL STANDARD

J I S

Testing method for apparent porosity,
water absorption and specific gravity of
refractory bricks

R 2205-1992

1. Scope

This Japanese Industrial Standard specifies the testing methods of burnt refractory bricks on the following respective items:

- (1) Apparent porosity
- (2) Water absorption
- (3) Apparent specific gravity
- (4) Bulk specific gravity
- (5) True specific gravity

Remarks: The applicable standards to this Standard are as given in the followings:

JIS Z 8401-Rules for rounding-off of numerical values

JIS Z 8801-Sieves for testing purposes

2. Equipment and instruments

2.1 Drying equipment An electric thermostatic vessel with automatic temperature regulator capable of maintaining the temperature at $110 \pm 5^\circ\text{C}$ shall be used.

2.2 Balance ⁽¹⁾

- (1) For the measurement of the bulk specific gravity, a balance which is capable of measuring to the unit of 1 g or 0.1 g shall be used.
- (2) For the measurement of the true specific gravity, a balance which is capable of measuring to the unit of 0.1 mg shall be used.

Note ⁽¹⁾ When the mass of test piece exceeds 1000 g, the balance shall be capable of measuring to the unit of 1 g, and when it is less than 1000 g, the balance shall be capable of measuring to the unit of 0.1 g.

2.3 Water saturating equipment

- (1) In the case of the boiling method, an equipment capable of maintaining the boiling point of water shall be used.
- (2) In the case of the vacuum method, an equipment capable of maintaining the vacuum to 2.0 kPa or under.

2.4 Pycnometer A glass pycnometer of 50 ml in capacity shall be used.

3. Test specimens

3.1 In the case of the apparent porosity, water absorption, apparent specific gravity and bulk specific gravity, test pieces shall be prepared from the sample of refractory brick to be tested, and the size of which shall be approximately cut to half or cut to 1/4 the ordinary shape brick.

Furthermore, as regards the handling of the test piece, care shall be taken concerning the following respective items.

- (1) The sample shall have been well cleaned of dust, dirt and particles liable to be peeled off in advance.
- (2) In appearance, the sample used shall be free from remarkable unevenness.

3.2 In the case of the true specific gravity, remove the foreign substances on the burnt surface of the refractory brick to be tested, pulverize to the degree to pass the standard sieve of 6.7 mm specified in JIS Z 8801, and take approximately 250 g by the quartering method. Next, pulverize so that the total amount can pass the standard sieve of 300 μ m specified in JIS Z 8801, take approximately 30 g by the quartering method, and take this as the sample.

4. Operations

4.1 For apparent porosity, water absorption, apparent specific gravity and bulk specific gravity

4.1.1 Dried mass Dry the sample in the thermostatic vessel at $110 \pm 5^\circ\text{C}$, and consider the mass when it has reached a constant mass ⁽²⁾ to be the dried mass W_1 (g).

Note ⁽²⁾ For the sample of approximately cut to half the ordinary shape brick, if no difference of 1 g or over is measured, the measured mass shall be considered to be a constant mass.

In addition, for the sample of approximately cut to 1/4 the ordinary brick, if no difference of 0.5 g or over is measured, the measured mass shall be considered to be a constant mass.

4.1.2 Method of saturation with water

- (1) In the case of the boiling method, after the dried mass has been weighed, submerge the sample under the water level of the boiling tank, boil for 3 hours or more, and allow it to cool down to the room temperature. Consider this to be the sample saturated with water. In this case, it may not be impedimental to cool by addition of water.
- (2) In the case of the vacuum method, after the dried mass has been weighed, place the sample on the bottom of the vacuum vessel, suck for 15 minutes under the vacuum of 2.0 kPa or under, and inject the medium liquid after the air in fine cavities has been eliminated completely. In this case, inject the medium liquid until the sample is soaked completely, then open the cock gradually, and leave standing for 30 minutes after the pressure has been lowered to the atmospheric pressure.

However, in the case where it is liable to cause hydration in the vacuum method, use white kerosine for the medium liquid. In this case, measure the specific gravity of the white kerosine at the test temperature, and consider it to be S . When water is used for the medium liquid, consider S to be 1.

- Remarks 1. Allow the vacuum pump to actuate during injection of the medium liquid, and stop after injection.
2. Measure the specific gravity of the white kerosine to the unit of 0.001.

4.1.3 Mass in water of sample saturated with water Weigh the sample saturated with water as suspended in water with wire of 1 mm or under in diameter, and consider the subtracted value of the mass of the wire to be the mass in water W_2 (g).

4.1.4 Mass of sample saturated with water Take out the sample saturated with water from the water, wipe the surface with wet cloth rapidly, weigh after water drops have been removed, and consider this to be the mass saturated with water W_3 (g).

Remarks: In the case the white kerosine has been used for the medium liquid in the operations of 4.1.3 and 4.1.4, operation shall be carried out by substituting white kerosine for water.

In addition, the wet cloth used shall be wringed out after it has been submerged well in the medium liquid.

4.1.5 Weigh the mass accurately to the unit of 1 g or 0.1g.

4.2 In the case of true specific gravity

4.2.1 Test method Dry the sample in accordance with 4.1.1 as appropriate put 8 to 12 g into the 50 ml pycnometer of which mass P (g) has been weighed in advance to weigh, and consider this to be P_1 (g).

Next, put the distilled water or pure water of approximately half quantity into the pycnometer, heat quietly on a hot bath, and cool it down to ordinary temperature after the bubbles in water have been removed. Fill this with the distilled water or pure water up to the marked line, weigh its mass, and consider this to be P_2 (g).

However, consider the mass, when the pycnometer has been filled with the distilled water or pure water, to be P_2 (g).

4.2.2 Weigh the mass (g) accurately down to the fourth decimal place.

5. Calculation

5.1 Apparent porosity The apparent porosity P_0 (%) shall be calculated from the following formula, and be rounded off to one place of decimal in accordance with JIS Z 8401.

$$P_0 = \frac{W_3 - W_1}{W_3 - W_2} \times 100$$

where, W_1 : mass of dried sample

W_2 : mass in water of sample saturated with water

W_3 : mass of sample saturated with water

5.2 Water absorption The water absorption A_w (%) shall be calculated from the following formula, and be rounded off to one place of decimal in accordance with JIS Z 8401.

$$A_w = \frac{W_3 - W_1}{W_1} \times \frac{1}{S} \times 100$$

where, W_1 : mass of dried sample

W_3 : mass of sample saturated with water

S : specific gravity of medium liquid

5.3 Apparent specific gravity The apparent specific gravity D_a shall be calculated from the following formula, and be rounded off to two places of decimals in accordance with JIS Z 8401.

$$D_a = \frac{W_1}{W_1 - W_2} \times S$$

where, W_1 : mass of dried mass

W_2 : mass in water of sample saturated with water

S : specific gravity of medium liquid

5.4 Bulk specific gravity The bulk specific gravity D_b shall be calculated from the following formula, and be rounded off to two places of decimals in accordance with JIS Z 8401.

$$D_b = \frac{W_1}{W_3 - W_2} \times S$$

where, W_1 : mass of dried sample

W_2 : mass in water of sample saturated with water

W_3 : mass of sample saturated with water

S : specific gravity of medium liquid

5.5 True specific gravity The true specific gravity D_t shall be calculated from the following formula, and be rounded off to two places of decimals in accordance with JIS Z 8401.

$$D_t = \frac{P_1 - P}{(P_1 - P) - (P_3 - P_2)}$$

where, P : mass of pycnometer

P_1 : mass of pycnometer containing sample

P_2 : mass of pycnometer containing distilled water up to marked line

P_3 : mass of pycnometer containing sample and filled with distilled water up to marked line

6. Report

The apparent porosity, water absorption, apparent specific gravity, bulk specific gravity and true specific gravity shall be indicated by the mean values of calculated values of two respective test pieces. However, in the report, the apparent porosity and water absorption shall be rounded off to one place of decimal and the apparent specific gravity, bulk specific gravity and true specific gravity to two places of decimals.

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